

DESIGN OF BLACKBOARD DUSTER CLEANING MACHINE

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ABSTRACT

These days, teachers are getting affected by respiratory diseases and skin allergies because using a chalk for long duration. Continuous use of chalk dust also affects vision of a human being. As dust contains tiny particulates of chalk, they tend to accumulate in human respiratory system, which can create severe health issues. Traditionally, chalk dusters are being cleaned by beating the on floor, wall or hitting dusters together which triggers above problems and causes environmental pollution. Hence, it is necessary to design the machine, which will clean chalkboard dusters and achieve dust free environment in classrooms and laboratories. Design of a duster cleaning machine is presented in this paper.

KEYWORDS: Chalk Dust, Respiratory and Skin Allergies & Chalkboard Dusters

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1. INTRODUCTION

Teachers and chalk always go together. Chalk's particles are tiny enough to get accumulate and form a thin layer within respiratory system, which may lead to respiratory and skin allergies. It can disturb throat functioning, also affects vision badly. Many times doctors getting patients with the issues of throat pain, skin allergies or problems with respiratory systems, these all are the results of exposure to chalk dust. In educational institutes, the teaching-learning process is incomplete without the use of traditional blackboard and chalk. The tiny particles of chalk may spread in the surrounding areas like benches, floor or cloths. This can cause the health issues mentioned previously. The survey is done by other researchers in various cities facing this problem, and opinions come like- Teachers are suffering from this problems for many years. But they had no option, because ultimately they have to depend on their voice. No matter how teachers invest on their treatments to get rid of health issues caused by chalk dust, they cannot expect complete recovery.

Then the only option teachers can go for is to change the teaching method, or go for a low powder of dustless chalk. But, changing traditional way of teaching is somewhat, and adapting new one is somewhat difficult for the teachers. Also, using dustless or low powder chalk may cause asthma attacks or allergy for the students, who are Case in sensitive.

Because, casein, milk protein used in a dustless chalk while manufacturing. When these casein particles are inhaled they can cause congestion, coughing, sneezing or severe asthma attacks. The whole scenario results in to increase of absenteeism of students in schools and colleges, which ultimately lead to degrade of their educational performance. Air containing dust particles affects health of students and teachers as follows:

- Uncomfortable, unhealthy students cannot focus on learning and remain distracted, inactive. The productivity gets suffered due to lack of concentration.
- Students who are already casein sensitive or have issues like asthma gets badly affected due to chalk dust.
- Students tend to fall sick frequently which affects their attendance.
- Teacher's performance gets affected, if they are unwell because of over exposure to chalk dust.

2. LITERATURE REVIEW

2.1 Review of Earlier Research Work

K Pavan Prabhakar, H N Vignesh (2018) developed a duster cleaning machine using vacuum technology. They have designed a system which works on vacuum process for cleaning the blackboard duster with the help of the motor. Motor will run the vacuum pump. A simple on/off switch is also going to play minor role in this system for stopping the motor, and thus the vacuum pump.

When the controller button is pressed, the circuit gets activated and starts the vacuum process. And, the chalk eraser is moved over the vacuum slot. When this is done, the dust from the eraser is pulled out of the material due to the suction produced from the vacuum pump. Thus, it avoids the chalk dust entering into the classroom atmosphere.

The model is designed in CAED then manufactured and trials are taken. It is better way to clean the chalk dust than the traditional methods of cleaning the dusters. But the major disadvantage of this kind of set up is, one supposed to move the duster continuously.

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Dr. N. P. Mungle, Siddhant Shambharkar (2017) developed a mechanism, which is used to recover the dust from duster. They made a prototype of duster cleaning machine, which has several parts like base frame, connecting link, vertical column, DC motor, duster holder, vacuum pump etc. By using linkage mechanism, the equipment is operated. The duster is made hammered on the block, which helps to clean the chalk dust and a vacuum pump is installed to suck the chalk dust within the chamber. The design is made, manufactured and trials are taken. This machine mechanism cleans the duster with ease, the only effort the person has to do is to get the duster and fix it in the duster cleaning machine.

The major disadvantage of this kind of machine is, the chalk dust can accumulate to intricate parts of the machine. This cannot be cleaned with the help of vacuum only [2].

Gary W. Jones (2002) invented a chalk dust cleaner and receptacle for chalk board eraser, which has a box shaped container. This assembly is wall mounted and has a cover. This assembly cleans the chalk board eraser and collects the chalk dust. The box is designed so that, it is open from the top, and closed from remaining bottom, back and front.

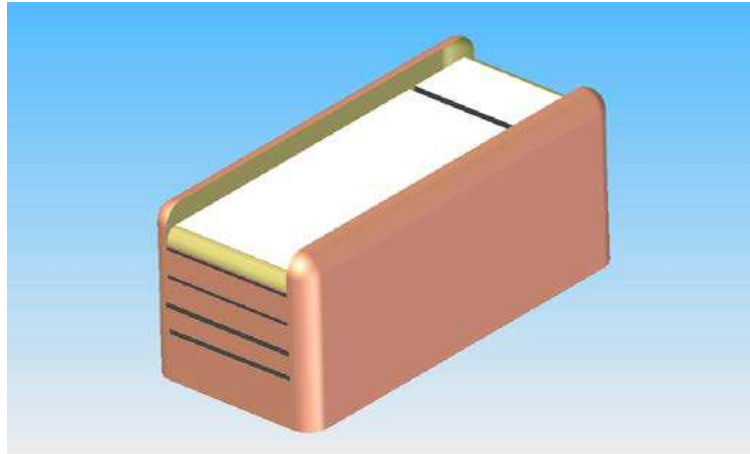


Figure 1: Model of a Duster Cleaner using Vacuum Pump.

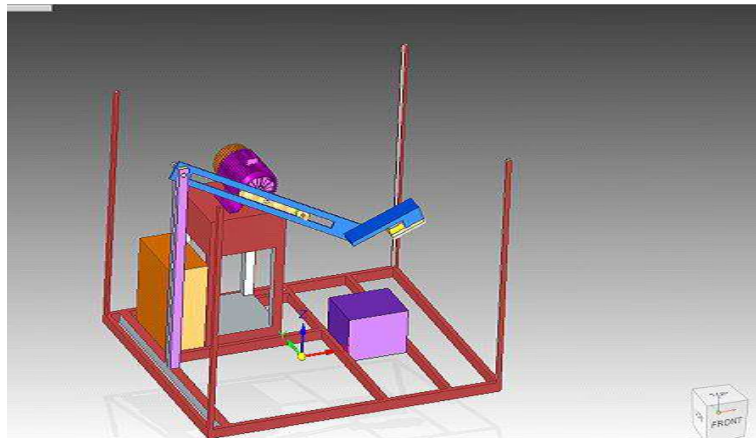


Figure 2: Model of a Duster Cleaning Machine by Hammering Duster.

The opening is provided from the top. It has pair of convex beads extending longitudinally. A scraper blade is provided on the top portion of the box, on which the duster can be rubbed, and the chalk dust tends to fall within the box can be collected later. The scraper blade can be changed time to time.

But as the complexity of receptacle is too high to manufacture, no industries has produced the same. [10]

Wen-Chin Lee (1986) invented a blackboard cleaning machine using roller mechanism. This machine is particularly used in black boards. The blackboard ultimately, chalk dust is cleaned by rolling friction and the dust is collected. This machine consists of a casing body in which the rollers are placed. It has a spare space at each end portion with an escape clack valve and a discharge door respectively, disposed in the opposing side walls. There are two types of rollers used for cleaning, master rollers and slave rollers. The master rollers performs the function of gathering chalk dust from blackboard and slave rollers remove dust from master rollers and discharge them to the chamber.

The major disadvantage of this kind of mechanism is it contains too many rollers, clamps which makes the design bulky and this is not user friendly. Also, the felt material which covers the rollers does not guarantee to absorb the chalk dust particles. This mechanism only displaces the dust and do not prevent it from spreading in the environment. [11]

2.2 Review of Existing Duster Cleaning Machines

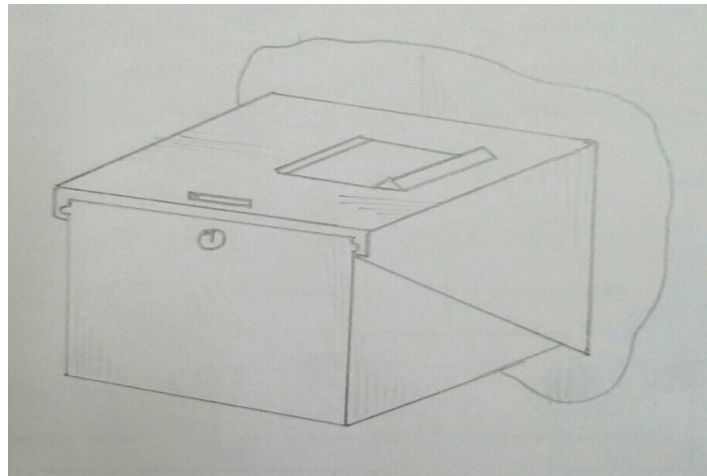


Figure 3: Chalk Dust Cleaner and Receptacle.

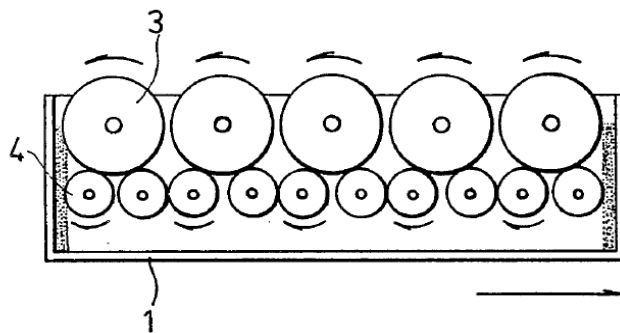


Figure 4: Blackboard Cleaning using Roller Mechanism.

Table 1: Existing Duster Cleaning Machines

Company Name/ Specifications	DustEZE (Taiwan)	Jefferson (China)	Buykorea (Korea)	Hurricane (Europe)
Size	305x 170x 185(mm)	114.3x 63.5x 63.5(mm)	285x 155x 175(mm)	280x 100(D) (mm)
Weight	2.5 Kg	2.8 Kg	2.5 Kg	-
Effectiveness	chalk dust / household dust	Chalk dust	Chalk dust	IT industries/ Computer Cleaning
Capacity of cleaning (At a time)	1	1	1	-

2.3 Findings of Literature Review

- Present method of cleaning black board duster is leading to air pollution, respiratory diseases and spreading of chalk dust on instruments, hands, walls etc.
- Machines, especially for cleaning of blackboard dusters, a very few persons only tried.

3. DESIGN

Proposed Design of Duster Cleaning Machine

Working

The proposed machine works on the principle of Roller follower and cam. As the supply of 12V DC motor is turned on, the shaft of motor starts to rotate which leads to rotate the bent rod. Rotating bent rod acts as a cam, due to which, the roller follower gets uniform circular motion. The hammering plate on which the rod of roller follower is welded gets lifted and due to self-weight made to hammer on dusters placed in duster holders. Hence, the dust is removed and whole assembly is enclosed in a casing to avoid spreading of dust to the environment.

Line diagram

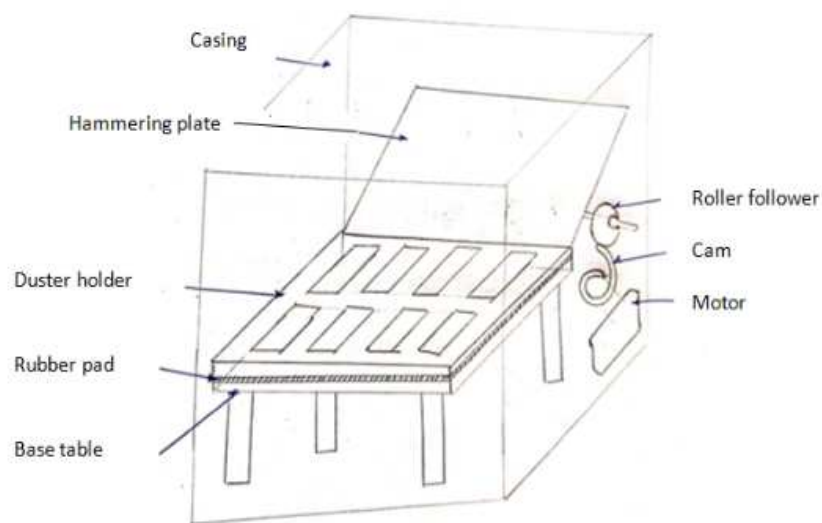


Figure 5: Line Diagram of Proposed Machine.

Model

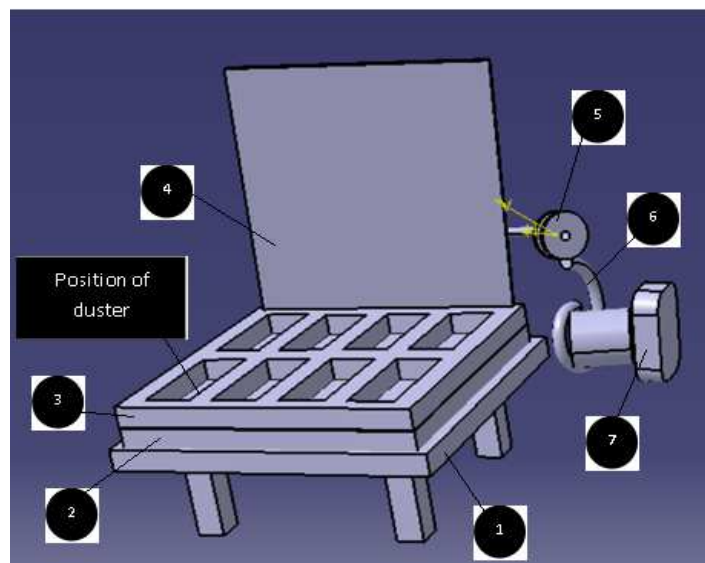


Figure 6: Proposed Design Modelled in CATIA.

Table 2: Part List

Part No.	Part Name	Reqd	Material
1	Base Table	1	Mild Steel
2	Rubber Pad	1	Rubber
3	Duster Holder	1	Mild Steel
4	Hammering Plate	1	Mild Steel
5	Roller Follower	1	Cast Iron
6	Cam	1	Mild Steel
7	DC Motor	1	-

Design of the components used in duster cleaning machine is as follows:

Base Table

Base table is having four legs made of mild steel square pipe. Rubber caps are provided at the bottom of the legs to reduce the vibrations to be transferred to floor. Above the legs a mild steel plate of 5 mm thick is fitted. To this plate, a duster holder frame is welded after keeping a rubber isolator. To cover all the parts & collect the dust, an enclosure box is provided, which fits to the table.

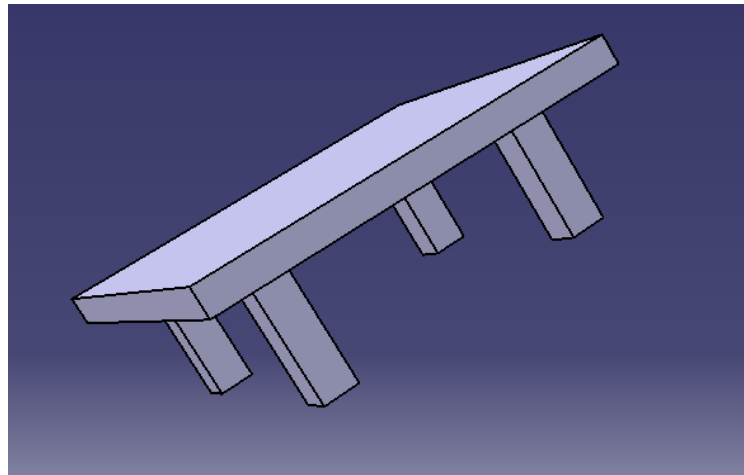


Figure 7: Base Table Modelled in CATIA.



Figure 8: Rubber Pad.

Rubber Pad

Rubber pad of 25mm thickness is used. The rubber pad acts as isolator during hammering of the duster for removal of dust. This also helps to reduce the noise caused by metal to metal contact (between duster holder and base table).

Duster Holder

For standard type of dusters, generally used in education institutes, the dimensions of duster holders are finalized.

- Dimensions of Duster: 150mmx40mmx30mm.

Mild Steel square pipes of 25mm side are used for this part. The slots are having dimensions 1–2mm larger than duster sides. This helps to eliminate the clamping part.



Figure 9: Dusters to be Cleaned.

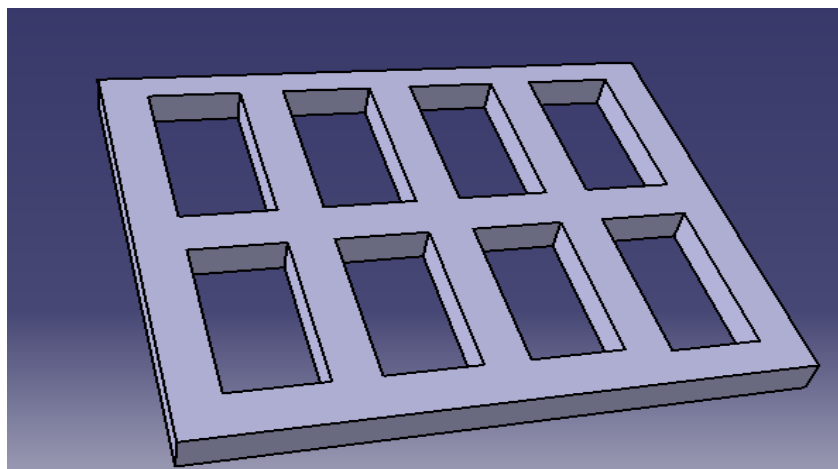


Figure 10: Duster Holder Modelled in CATIA.

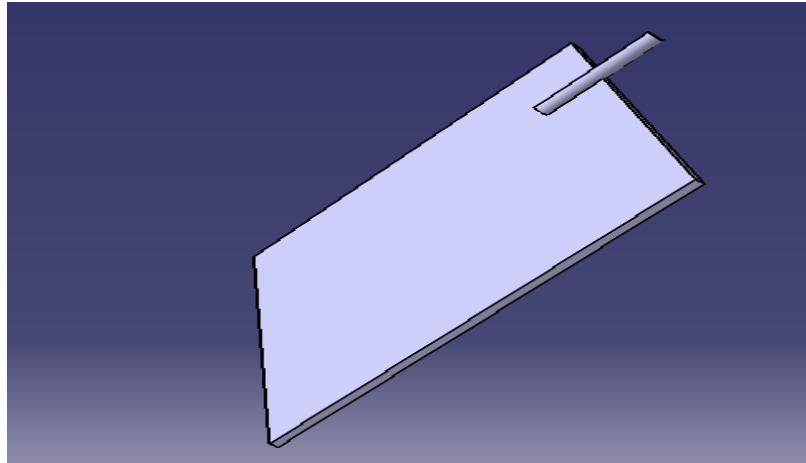


Figure 11: Hammering Plate Modelled in CATIA.

Hammering Plate

Hammering plate is clamped to the base table. As cam is made to rotate with the help of DC motor, the plate is elevated and due to its self-weight, hammering effect is produced.

Hammering plate is welded with a rod carrying roller follower.

Roller Follower

As mentioned before, a rod carrying roller follower is welded to hammering plate. Cam shaft will be rotated by motor, and this will lift the follower.

Cam

According to the lift required, the cam profile is drawn as below.

- Cam Profile

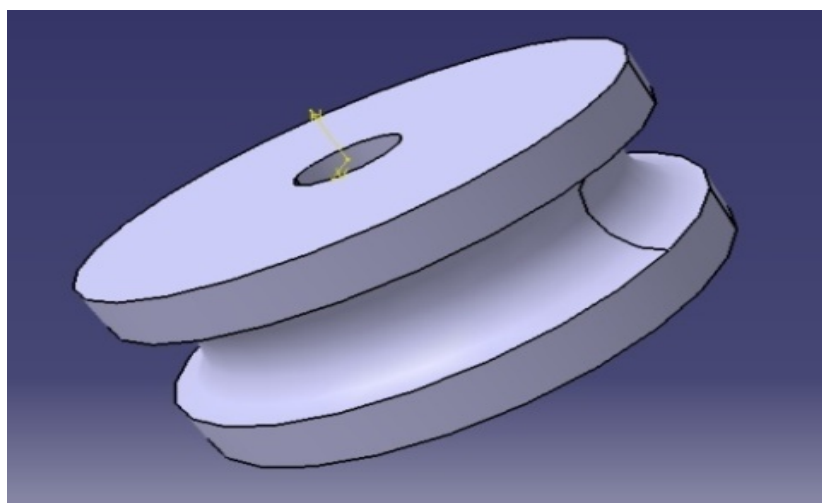


Figure 12: Modelling of Roller Follower in CATIA.

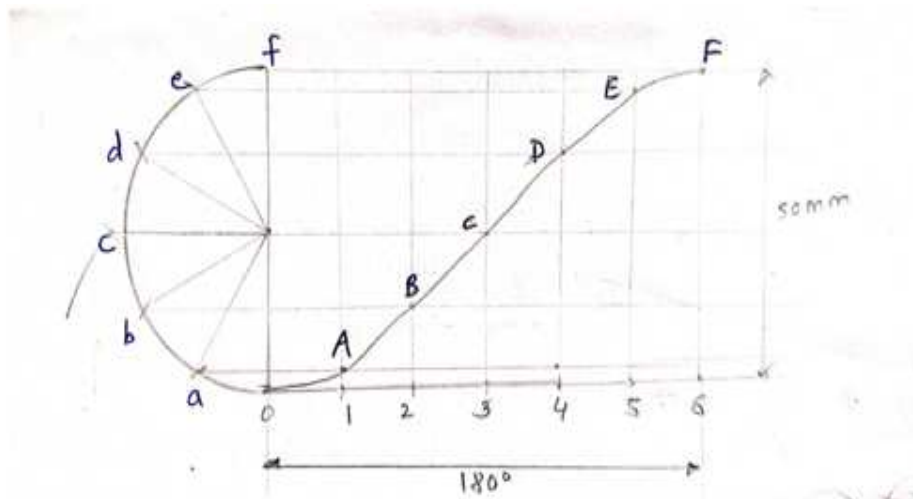


Figure 13: Displacement Diagram.

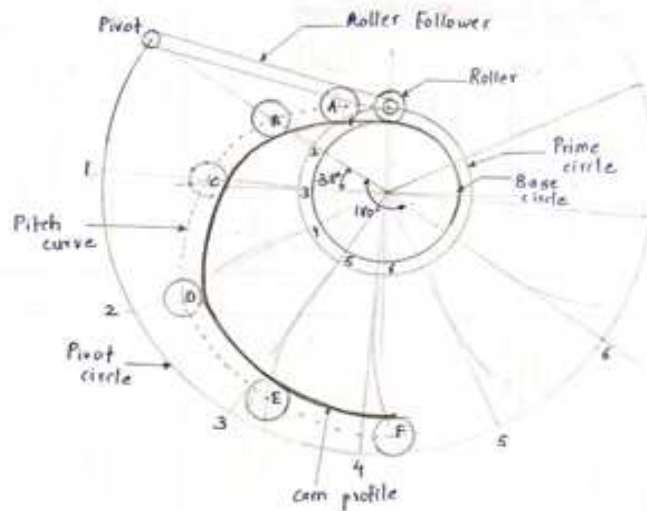


Figure 14: Cam Profile.

Bent rod is used as a cam.

Selection of Motor

The power required to lift the hammering plate is calculated as below:

- Weight of hammering plate = $3.5 \times 9.81 = 34.335 \text{ N}$
- Lift of follower = $50 \text{ mm} = 0.05 \text{ m}$

A DC motor of 40 rpm is under consideration.

- Time during which it is lifted once = $60/40 = 1.5 \text{ seconds}$
- Work done = weight x Lift / time = $34.335 \times 0.05 / 1.5 = 11.445 \text{ watts}$
- For this a DC motor of 40 rpm output (inbuilt reduction through hardened plastic worm gearing)

- The inputs to this motor are 12 volts x 1.5 A; which leads to input power of 18 Watts.

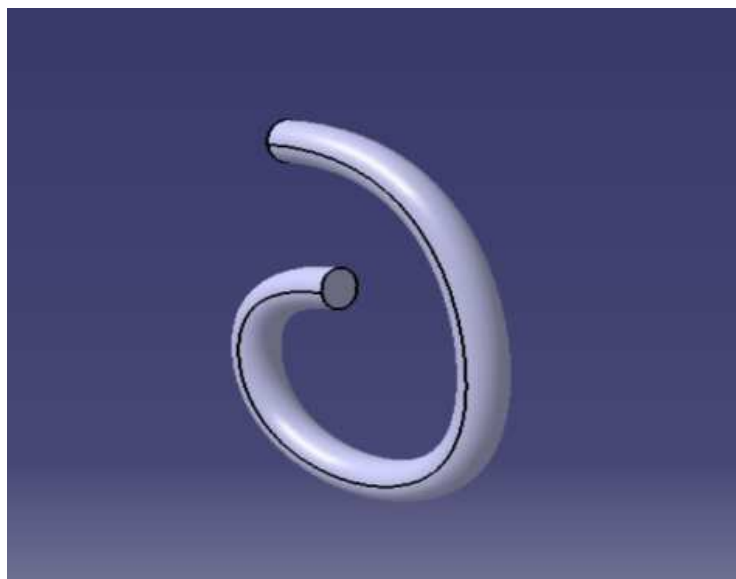


Figure 15: Bent Rod Modelled in CATIA.

4. CONCLUSIONS

Proposed design will reduce the air pollution caused by dust particulates, which will lead to reduce health issues caused by chalk dust. Absorption of dust may be done by using vacuum pump, which will prevent accumulation of dust particles on the equipment in laboratories, libraries, and gymnasiums.

5. ACKNOWLEDGEMENT

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